

REMARKS

Applicant thanks the Examiner for the very thorough consideration given the present application.

Claims 1-10 are now present in this application. Claims 1-10 are allowed.

Amendments have been made to the Abstract of the Disclosure and specification. Reconsideration of this application, as amended, is respectfully requested.

I. Priority Under 35 U.S.C. § 119

Applicant thanks the Examiner for acknowledging Applicant's claim for foreign priority under 35 U.S.C. § 119, and receipt of the certified priority document.

II. Abstract of the Disclosure

Applicant has amended the Abstract of the Disclosure in order to place it in better form.

III. Specification Objection

In order to overcome this objection, Applicant has amended the

specification in order to correct the deficiency pointed out by the Examiner. In addition, a Substitute Specification is being provided in order to place the application in better form. Also included is a marked-up copy of the original specification which shows the portions of the original specification which are being added and deleted. Applicant respectfully submits that the substitute specification includes no new matter and that the substitute specification includes the same changes as are indicated in the marked-up copy of the original specification showing additions and deletions. Reconsideration and withdrawal of this objection are respectfully requested.

IV. Additional Cited References

Since the remaining references cited by the Examiner have not been utilized to reject the claims, but have merely been cited to show the state of the art, no comment need be made with respect thereto.

V. Conclusion

All of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. Applicant therefore respectfully requests that the Examiner reconsider all presently outstanding rejections and that they be withdrawn. It is believed that a full and complete response has been made to the

outstanding Office Action, and as such, the present application is in condition for allowance.

If the Examiner believes, for any reason, that personal communication will expedite prosecution of this application, the Examiner is invited to telephone James T. Eller, Jr., Registration No. 39,538, at (703) 205-8000, in the Washington, D.C. area.

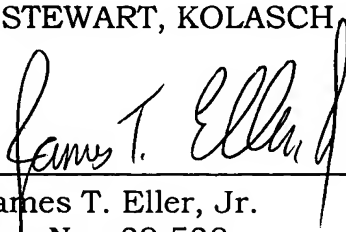
Prompt and favorable consideration of this Amendment is respectfully requested.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. §§ 1.16 or 1.17; particularly, extension of time fees.

Respectfully submitted,

BIRCH, STEWART, KOLASCH & BIRCH, LLP

By:

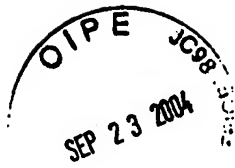


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Attachment(s): Abstract of the Disclosure
Substitute Specification (with marked-up copy)



APPARATUS FOR PREVENTING REVERSE ROTATION OF SCROLL COMPRESSOR

BACKGROUND OF THE INVENTION

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1. Field of the Invention

The present invention relates to a scroll compressor, and more particularly, to an apparatus for preventing reverse rotation of a scroll compressor capable of preventing a compressor from being driven in a direction opposite to a driving
10 direction of compressing a fluid.

2. Description of the Background Art

In general, several types of compressor according to a compression method can be applied to various devices, and, for a small sized and lightweight
15 air conditioning device, a scroll compressor is mainly used.

Figure 1 is a sectional view of a scroll compressor according to the conventional art.

A scroll compressor according to the conventional art includes a casing 1 to which a suction port 11 through which a fluid is sucked and a discharging port 12 through which a compressed fluid is discharged are connected respectively,
20 forming a certain close space; a driving unit (D) mounted at a lower portion of the casing 1, and generating a driving force; a compression unit (P) positioned at an upper portion of the casing 1 to compress a fluid sucked through the suction port 11 and discharge the compressed fluid through the discharging port 12, using a
25 rotational force of a rotational shaft 23, which is generated by the driving force of

the driving unit (D).

A main frame 2 for supporting the compression unit (P), and supporting one end of the rotational shaft 23 to make rotation of the rotary shaft 23 possible, is installed at an upper portion of the casing 1. A lower frame 3 for rotatably supporting the other end of the rotational shaft 23 is installed at a lower portion of the casing 1.

The driving unit (D) includes a stator 4 mounted in the casing 1, and a rotor 5 rotatably inserted at the inside of the stator 4, and, at the inside of the rotor 5, the rotational shaft 23 is pressed and inserted. The rotational shaft 23 includes a shaft portion 20 having a certain length, and pressed and inserted at the rotor 5, and an eccentric portion 21 formed at one end of the shaft portion 20 to be eccentric from the center of the shaft portion 20, and connected with the compression unit (P).

The compression unit (P) includes a fixed scroll 7 fixedly coupled with the main frame 2, and an orbiting scroll 8 meshed with the fixed scroll 7, and also coupled with the rotational shaft 23. A slide bush 6 is inserted at a lower portion of the orbiting scroll 8, and the eccentric portion 21 of the rotational shaft 23 is inserted to be coupled with the slide bush 6. A suction hole 7a through which gas, which has passed through the suction pipe 11, is flown into a compression space formed between the orbiting scroll 8 and the fixed scroll 7, is formed at one side of the fixed scroll 7. At an upper portion of the fixed scroll 7, a discharging hole 7b through which compressed gas is discharged, is formed, and, at an upper side of the discharging hole 7b, a check valve (not shown) for preventing the discharged fluid from flowing backward, is installed. An Oldham ring 9 for preventing self-rotation of the orbiting scroll 8 is installed between the orbiting scroll 8 and the

main frame 2. At an upper surface of the fixed scroll 7, a dividing plate 10 for dividing the inside of the casing 1 into a low pressure area (N) and a high pressure area (M), is installed.

Figure 2 is a disassembled perspective view showing a slide bush and an
5 eccentric portion of a rotational shaft according to the conventional art.

As shown therein, the eccentric portion 21 of the rotational shaft has a cylindrical form with a certain length. At an outer circumference thereof, a first and second outer planes 23a and 23b are formed so as to be parallel with or have a predetermined angle on the basis of a reference line connecting the center of the
10 shaft portion 20 of the rotational shaft and the center of the eccentric portion 21, and outer circumferential surfaces 24a and 24b connecting the first and second outer planes 23a and 23b are formed.

Also, the slide bush 6 has a cylindrical form with a certain length, and an inserting hole 40 penetrates the inside of the slide bush 6 so that the eccentric
15 portion 21 of the rotational shaft can be inserted therein at a variable gap therebetween. At an inner circumferential surface of the suction hole 40, a first and second inner planes 26a and 26b are formed so as to confront with the first and second outer plane 23a and 23b formed at the outer circumferential surface of the eccentric portion 21 of the rotational shaft respectively.

20 Operations of the conventional scroll compressor configured as above will now be described.

When power is applied to a stator 4, a rotor 5 rotates by an electromagnetic interaction of the stator 4 and the rotor 5, and a rotational shaft 23 fixed at the rotor 5 rotates forwardly. At this time, one of the first and second outer
25 planes 23a and 23b, which is formed toward a forward rotation direction on the

basis of the reference line connecting the axis of the shaft portion 20 of the rotational shaft 23 and the axis of the eccentric portion 21 thereof is in contact with one of the first and second inner planes 26a and 26b of the inner circumferential surface of the inserting hole 40 of the slide bush 6. Through this contact of the
5 planes, the rotational force of the rotational shaft 23 is transmitted to the slide bush 6, and, after all, transmitted to the orbiting scroll 8 inserted at and connected with an outer circumferential surface of the slide bush 6. At this time, the orbiting scroll 8 starts to orbit.

A fluid sucked through the suction port 11 by the interaction of the orbiting
10 scroll 8, which is orbiting, and the fixed scroll 7, is compressed and discharged to the outside.

At this time, a check valve (not shown) installed at the discharging hole 7b prevents the fluid, which has been discharged to a high pressure area (M) through the discharging hole 7b, from flowing backward to the low pressure area (N).

15 However, to the conventional scroll compressor above, several apparatuses for preventing reverse rotation is applied in order to prevent damage of the compressor, which is caused by the reverse rotation generated by the following reasons, but there are still remained problems below.

In case of applying a single-phase motor as a driving unit for generating a
20 rotational force, if a load generated during an operation of the compressor becomes greater than a motor torque, a rotational force of a motor is reduced, further, the motor is rotated reversely, and thus, the orbiting scroll is rotated reversely, Accordingly, an abnormal oscillation and noise of the compressor are generated, and reliability of the compressor is deteriorated.

25 Also, in case of applying a three-phase motor as a driving unit for

generating a rotational force, if wiring of a motor is not right, and so supply power is changed, the motor is rotated reversely, and thus the compressor is damaged. In order to solve this problem, a reversed-phase preventing circuit is attached. When the phase of the supply power is changed, the reverse-phase preventing
5 circuit turns off power supplied to the compressor so that the compressor cannot be operated, and thus protects the compressor. However, since, in installing the circuit, expenses are increased, and there still exists a possibility for the compressor to be ill-operated according to a complicated configuration, reliability of the compressor is deteriorated.

10 Also, there is a method applying a single direction clutch structure between the rotational shaft 23 and a lower frame 3, but in this case, expenses for installing is increased too. Also, since a roller portion of a clutch has to be continuously operated therewith even in a normal operation, damage of power is generated whereby efficiency is deteriorated, and noise is generated too by an
15 unnecessary movement.

SUMMARY OF THE INVENTION

Therefore, an object of the present invention is to provide an apparatus for
20 preventing reverse rotation of a scroll compressor capable of preventing damage of a compressor and an abnormal oscillation and noise, and reducing expenses in installing, by restraining a orbiting scroll from being driven in a reverse direction, which is caused since a driving unit of a compressor is driven in a direction opposite to a direction of compressing a fluid, or a load generated during an
25 operation of the compressor is greater than motor torque.

To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, there is provided an apparatus for preventing reverse rotation of a scroll compressor including a casing, a fixed-scroll installed inside the casing, a orbiting scroll meshed with the fixed scroll and defining a compression unit therewith, a rotational shaft having a shaft portion combined with a driving unit and an eccentric portion integrally formed to be eccentric from the center of one end of the shaft portion and a slide bush disposed between the eccentric portion of the rotational shaft and the orbiting scroll, wherein said apparatus comprises the eccentric portion of the rotational shaft having two outer planes formed at an outer surface thereof, and a sloping plane extended from one of the two outer planes, the sloping plane sloping on the basis of a reference line connecting the axis of the shaft portion of the rotational shaft and that of the eccentric portion thereof, and the slide bush where an inserting hole penetrates so that the eccentric portion can be inserted therein, including two inner planes formed at an inner surface of the inserting hole thereof for confronting with the planes formed at an outer surface of the eccentric portion of the rotational shaft, and a sloping plane slopingly extended from one of the two inner planes.

The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a unit of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention.

5 In the drawings:

Figure 1 is a vertical sectional view of a scroll compressor according to the conventional art;

Figure 2 is a disassembled perspective view showing a conventional eccentric portion of a rotational shaft and a slide bush.

10 Figure 3 is a disassembled perspective view showing an eccentric portion of a rotational shaft and a slide bush according to the present invention;

Figure 4 is a plane view of Figure 3 showing an eccentric portion of a rotational shaft and a slide bush in rotating in a forward direction according to the present invention; and

15 Figure 5 is a plane view of Figure 3 showing an eccentric portion of a rotational shaft and a slide bush in rotating in a reverse direction according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

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Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

Hereinafter, an apparatus for preventing reverse rotation of a scroll compressor according to one embodiment of the present invention will now be
25 described in detail with reference to accompanying drawings.

In drawings, a structure, which is the same as that of the conventional art, will have the same numeral, and overlapped descriptions will not be mentioned.

Figure 3 is a disassembled perspective view showing an eccentric portion of a rotational shaft and a slide bush. Figure 4 is a plane view of Figure 3 showing an eccentric portion of a rotational shaft and a slide bush in rotating in a forward
5 direction according to the present invention. Figure 5 is a plane view of Figure 3 showing an eccentric portion of a rotational shaft and a slide bush in rotating in a reverse direction according to the present invention.

As shown in Figure 3, an apparatus for preventing reverse rotation of a scroll compressor according to the present invention includes a cylindrical
10 eccentric portion 210 formed at one end of a shaft portion 200 of a rotational shaft 23 connected to a driving unit (D) and thus rotated so as to be eccentric from the axis of the shaft portion 200; and a cylindrical slide bush 60 having a inserting hole 400 penetrating its center so as to be coupled with the eccentric portion 210 at a
15 variable gap therebetween.

At an outer circumferential surface of the eccentric portion 210, two outer planes 50a and 50b are oppositely formed to be parallel to or have a certain angle on the basis of a reference line connecting the center of the shaft portion 200 of the rotational shaft and the center of the eccentric portion 210. Between both ends
20 of the outer planes 50a and 50b, an outer outer-circumferential surface 52 and an inner outer-circumferential surface 53 are formed respectively. And a first sloping plane 70 is extended from the outer plane 50a, one of the outer planes 50a and 50b, which is positioned toward a reverse rotation direction on the basis of the reference line. The first sloping plane 70 is formed to be adjacent to an outer
25 circumference of the shaft portion of the rotational shaft.

An inner circumferential surface of the inserting hole 400 formed at the slide bush 60 is formed to confront with the planes formed at the outer circumference surface of the eccentric portion 210. Two inner planes 51a and 51b are formed at the inner circumferential surface of the inserting hole 400 respectively so as to confront in parallel with the two outer planes 50a and 50b of the eccentric portion 210. Between the inner planes 51a and 51b, an outer inner-circumferential surface 54 and an inner inner-circumferential surface 55 are formed respectively. A second sloping surface 80 is slopingly extended from the inner surface 51b, one of the inner planes 51a and 51b, which is positioned toward a reverse rotation direction on the basis of the reference line. The second sloping plane 80 is formed to be adjacent to an outer circumference of the shaft portion of the rotational shaft.

According to this, when the outer plane 50a, one of the outer planes 50a and 50b of the eccentric portion 210 of the rotational shaft, from which the first sloping plane 70 is not extended, and the inner plane 51a, one of the inner planes 51a and 51b of the slide bush 60, from which the second sloping surface 80 is not extended, are in contact with each other, and operated in a forward direction, that is, in a direction of compressing a fluid, these two planes become a forward rotation operating surface 50a and 51a. On the contrary, when the first sloping plane 70 of the eccentric portion 210 and the second sloping plane 80 of the slide bush are in contact with each other, and operated in a reverse direction, that is, in a direction opposite to a direction of compressing a fluid, these two planes become a reverse rotation operating surface 70 and 80.

Here, an angle between the operating surfaces 70 and 80 in the reverse rotation and the reference line is greater than an angle between the operating

surfaces 50a and 51a in the forward rotation and the reference line by a predetermined value.

Meanwhile, it is advisable that the angle between the reference line and the operating surfaces 70 and 80 in the reverse rotation is between 45 and 90
5 degrees.

Hereinafter, operations of an apparatus for preventing reverse rotation for the scroll compressor according to the present invention will now be described.

Figure 4 is a plane view showing a positional relation between the eccentric portion of the rotational shaft and a slide bush when the rotational shaft
10 of the scroll compressor rotates in a direction of compressing a fluid according to the present invention. Figure 5 is a plane view showing a positional relation between the eccentric portion of the rotational shaft and the slide bush when the rotational shaft of the scroll compressor rotates in a reverse direction.

As shown in Figures 4 and 5, an operation angle between the reference
15 line, which connects the center of the shaft portion 200 of the rotational shaft 23 and the center of the eccentric portion 210, and the reverse rotation operating surface 70 and 80 is greater than that between a reference line and the forward rotation operating surface 50a and 51a by a predetermined value. Through this difference of angles, in rotating in a forward direction of compressing a fluid, a
20 wrap of the orbiting scroll 8 is adhered to a wrap of the fixed scroll 7 by a proper force operating in a radial direction so that gas can be compressed in a compression space formed by the two wraps. Also, in rotating in a reverse direction, by the force operating in a radial direction, a frictional force between the orbiting scroll 8 and the fixed scroll 7 is greater than activating torque of a motor of
25 the driving unit (D) so that reverse rotation of the compressor can be prevented.

In general, the force operating in a radial direction can be simply calculated by an expression below.

$$Frs = F\omega - Fgr + Fgt \cdot \tan(\alpha - \phi)$$

herein,

$F\omega = F\omega.os + F\omega.sb$ (centrifugal force of orbiting scroll + centrifugal force of slide bush)

$Fgr = 2 \times a \times h \times (Pd - Ps)$: gas reaction force operating in a radial direction

Pd : discharge pressure

Ps : suction pressure

a : radius of basic circle having scroll wrap form

h : height of wrap

Fgt : gas reaction force operating in a tangent line direction
(determined by form of wrap and operation condition of compressor)

α : operation angle

ϕ : $a \tan(\tau) = .05$ (τ : surface friction coefficient of operation surface)

5 In case of a general compressor, in consideration that Fgt is 10 times more than Fgr , Frs (force operating in a radial direction) rapidly increases according to an increase of an operation angle (α).

As so far described, the apparatus for preventing reverse rotation of a

scroll compressor according to the present invention can prevent damage of the compressor, which is caused because the inside of the compression unit forms a vacuum in case that a driving unit of the compressor is driven in a direction opposite to the direction of compressing a fluid, or that the driving unit is driven in the opposite direction since a load generated during an operation of the compressor is greater than motor torque. Consequently, safety and reliability of the compressor can be improved, and productivity is also improved since the apparatus for preventing reverse rotation has a simple structure to be easy to be produced. In addition, the apparatus for preventing reverse rotation can implement the same function as in case of adding a conventional reversed-phase preventing circuit or applying a single direction clutch structure with much reduced expenses.

As the present invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, it should also be understood that the above-described embodiments are not limited by any of the details of the foregoing description, unless otherwise specified, but rather should be construed broadly within its spirit and scope as defined in the appended claims, and therefore all changes and modifications that fall within the metes and bounds of the claims, or equivalence of such metes and bounds are therefore intended to be embraced by the appended claims.